Midterm 1 Study Guides

The test covers all the material discussed so far up to and including section 5.1 and homeworks 1 through 3. The following set of questions is meant to help guide your study and is not meant to be exhaustive of all the possibilities.

1. Be able to write a SISO Python program that performs simple prescribed tasks (the isPrime and lengthGreaterThan10 kinds of programs).
2. Describe the intented behavior of the programs named yesOnString, notYesOnSelf. Then:
   - Prove that the program notYesOnSelf cannot exist.
   - Show how we can write the program notYesOnSelf by using yesOnString as a helper.
   - Explain why yesOnString cannot exist.
3. Describe reasonable ways to encode each of the following as a single string. Explain both the encoding and the decoding process.
   - A pair of strings of arbitrary length
   - A arbitrary-length list of positive integers
   - A graph, and a weighted graph (page 48)
   - An arbitrary number of strings of arbitrary length
4. Provide precise definitions for each of the following, as well as at least two examples for each:
   - An *alphabet* Σ.
   - A *string* over an alphabet Σ.
   - A *language* over an alphabet Σ (hint: lots of good examples on page 51).
   - The language L^* for a given language L.
   - The language LM for given languages LM.
   - The language $\bar{L}$ for a given language L over an alphabet Σ.
   - A *computational problem* over an alphabet Σ.
   - What it means for a program P to *solve* a given computational problem F.
   - A *decision problem* over an alphabet Σ.
   - The language L_D for a decision problem D.
   - *positive* and *negative* instances of a decision problem.
   - The problem isMEMBER(L) for a given language L over an alphabet Σ.
5. Define what it means for a language to be *decidable*, and what it means for it to be *recognizable*.

6. Prove that if a language L is decidable, then:

   - The complement language $\bar{L}$ is also decidable
   - If another language M is decidable then the intersection and union languages $L \cap M$, $L \cup M$ are both decidable.

7. Prove that if L is decidable then L is also recognizable.

8. Provide a precise definition of a *Turing Machine* over an alphabet Σ.

9. Be able to describe the computation of a Turing Machine based on its state diagram (see p. 76).

10. Be able to write the state diagrams for Turing Machines that accomplish simple tasks.

11. Explain the difference between *accepters* and *transducers* and provide examples of each.

12. Can a problem "loop"? What does that mean? What about a Turing Machine? What about a Python program?